The G5RV* by "the Man Himself"

Loius Varney G5RV

* Reprinted from "Ohm" Magazine with corrections submitted by the author

The G5RV aerial is a multi-band dipole specifically designed with dimensions which allow it to be installed in most normal-sized back gardens, permitting effective operation from 1.8 to 30 MHz.

As the G5RV aerial does not make use of traps or ferrite beads, the "dipole" portion becomes progressively longer in electrical length with increasing frequency. This effect confers certain advantages over a normal or trap dipole because, with increasing electrical length, the major lobes of the vertical radiation patterns tend to be lowered as the frequency is increased.

Thus, from 7 MHz up, most of the energy radiated in the vertical plane is at an angle suitable for DX working. Furthermore, the horizontal polar diagram changes with increase of frequency from a more or less typical half wave horizontal dipole diagram to that of a typical "long wire" aerial at 14, 21 and 28 MHz.

Although the impedance matching of a suitable (non-critical) length of 75 ohm twin feeder (preferred) or 75 to 80 ohm co-axial feeder from the base of the matching stub to the transmitter or preferably, to a suitable aerial tuning unit, is approximate only for most brands, a very good match indeed is obtained on 14 MHz. It so happens also that the polar diagram on this band is that of a three-half-wavelength long-wire which is particularly suitable for all-round DX working and gives an estimated gain of about 3 dB over a simple dipole in the directions of the four major lobes.

The above reasoning does not apply to its use on 1.8 MHz where it functions as a Marconi or T-aerial with most of the effective radiation taking place from the vertical or near-vertical portions of the system, the "flat top" acting as a top-capacity loading element. However, with the transmitter end of the feeder strapped and with the system tuned to resonance with a suitable series inductance and capacitor circuit connected to a good earth, or a counterpoise, very effective radiation on this band is obtainable even when the flat top is as low as 25 feet above ground.

CONSTRUCTION

The dimensions of the aerial and matching stub are as shown in Fig. 1. It should be noted that it is quite in order to "bend" the lower half of the matching stub if desired owing to relatively low height above ground of the flat top. The writer has used this aerial for many years at a height of only 25 feet with excellent results on all bands from 1.8 to 28 MHz.

A word about the matching stub is in order. If this is of open wire feeder construction (preferred because of lower losses, especially at 21 and 28 MHz) its length should be 34 feet (17 feet for the half-size version), but if 300 ohm ribbon is used allowance must be made for the velocity factor of this type of twin-lead. Since this is approximately 0.88, the actual physical length of the 300 ohm ribbon stub should be 29 feet 6 inches. It should be borne in mind that this matching stub is intended to resonate as a half-wave impedance transformer at 14 MHz, which was chosen as the design centre frequency for the G5RV aerial, thus giving a very good impedance match for a 75 to 100 ohm twin-lead or co-axial cable connected to the base of the stub.

If desired, due to lack of sufficient space to accommodate the 102 feet long flat top, the ends of the aerial may be dropped vertically (or semi-vertically) for up to 10 feet at each end, thus reducing the overall length to 82 feet.

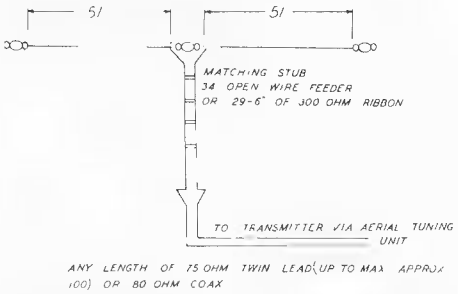

51
51
MATCHING STUB
34 OPEN WIRE FEEDER
OR 29-6" OF 300 OHM RIBBON
TO TRANSMITTER VIA AERIAL TUNING UNIT
ANY LENGTH OF 75 OHM TWIN LEAD (UP TO MAX APPROX 100) OR 80 OHM COAX

FIG. 1: Dimensions of the full-size G5RV Aerial. For the half-size version, the dimensions of the flat-top and matching stub are scaled proportionately.

An alternative arrangement to that of the matching stub and twin-lead or co-axial cable feeder is to use an 83 feet length of open-wire feeder measured from the centre of the flat top to the terminals of the ATU. This arrangement permits parallel tuning of the ATU on all bands from 3.5 to 28 MHz with very low feeder losses.

The spacing of either the open-wire stub or the 83 ft. long open-wire feeder is not critical and may conveniently be anything from 2 to 6 inches, using either 14 or 16 SWG copper wire. Although the use of 14 SWG is recommended for the flat top, 16 SWG is adequate for the matching stub or tuned feeder and is easier to "hang" neatly.

It is recommended that attention be paid to making a sound mechanical job of the construction of the aerial. In particular, if 300 ohm ribbon is used for the matching stub, the ribbon should be looped over the centre insulator of the flat top and secured with nylon thread or plastic tape, leaving "flying" ends about 9 inches long forming two loops for connection to each half of the aerial. This type of construction avoids breaking of the ribbon due to swinging and vibration in high winds. Alternatively, a suitable triangular shaped ceramic or plastic dipole centre insulator which is designed to secure the 300 ohm ribbon may be used.

Although it may be very convenient to use a length of, say, up to 100 ft. of co-ax. direct from the transmitter to the base of the matching stub, it must be remembered that such an arrangement will tend to produce currents which will flow in the outer conductor of the co-ax., causing unwanted radiation from the co-axial feeder. This may be avoided by the use of either 75 ohm twin-lead and a suitable ATU or the open-wire feeder and ATU as already mentioned.

Nevertheless, in practice very satisfactory operation can be achieved by the simple use of co-ax. direct from the transmitter to the base of the matching stub even though the VSWR may reach 10 to 1 or more on 3.5 MHz. This figure may be reduced to about 5 to 1 on 3.5 MHz by "pruning" the co-ax. On the higher frequency bands the VSWR on the co-ax. lies between 5 to 1 and 1.5 to 1, the latter figure applying to 14 MHz, where, as explained above, the matching is very good.

Contrary to general belief, a VSWR of up to 5 to 1 on a length of co-ax. up to about 100 feet, at the frequencies considered here, results in negligible loss of power. However, this is not to say that it is not better to keep the VSWR figure as low as possible, especially where a low-pass TVI filter is to be used. It is mainly for this reason that the writer prefers to use a convenient length of 80 ohm co-ax. from the transmitter to an ATU and then 75 ohm twin-lead to the base of the stub. In this way, using a low-pass filter and a VSWR meter in the length of co-ax., a perfect, or near perfect, match can be obtained for the transmitter and filter on all bands.

THE AERIAL TUNING UNIT

As stated above, the writer prefers to use an ATU for the reasons given. There are various satisfactory forms of ATU but one which the writer has used for many years and which is extremely flexible electrically and yet does not require the coils to be tapped for optimum feeder loading, is shown in Fig. 2.

In any case, whatever form of ATU is used a suitable VSWR meter should be inserted in the co-ax. feeder from the transmitter output to the ATU. Optimum loading and maximum harmonic suppression will be achieved by watching the reverse current in the VSWR meter and adjusting both ATU tuning and loading capacitors for minimum reverse current.

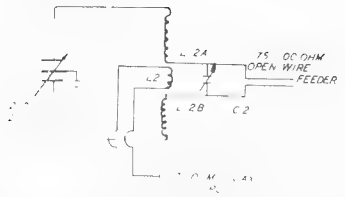


FIG. 2: A suggested aerial tuning unit for use with the G5RV aerial. C1 is a 200/200 pF split-stator transmitter capacitor, the plate spacing being determined by the power it will have to handle. The coupling capacitor C2 consists of three 500 pF broadcast receiver variable capacitors connected in parallel. If necessary, this combination may be supplemented by a bank of switched high-voltage mica capacitors.

If the link-coupling coil is common for all bands (using plug-in ATU coils) it is preferable that it be of the "swinging" type, i.e. adjustable coupling. It will be found that, starting with the link coil fully coupled, normally, after the ATU tuning and loading capacitors have been adjusted to give the lowest possible reverse current, adjustment of the link-coil coupling will, in nearly all cases, permit a VSWR of virtually 1 : 1 to be obtained on the co-ax. cable to the transmitter.

However, if ATU coils having individual link-coils are used, the number of turns on each link should be adjusted to suit the actual conditions applying to a particular installation for each of the bands.

For a common, swinging, link-coil three turns is about as good a compromise as may easily be obtained.

Table 1 gives coil winding details for each band.

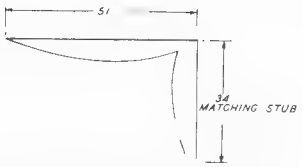


FIG. 3: The current distribution of the G5RV aerial at 3.5 MHz. Only one half is shown. The aerial functions as a half-wave dipole partially folded up at the centre. Some reactive mismatch occurs at the base of the matching stub, but performance is very good despite a rather high VSWR on 75 ohm co-ax. or 75 ohm twin feeder to the transmitter or ATU.

7 MHz—A similar arrangement exists at this frequency except that the flat top plus 16 ft. of the matching stub now functions as a partially folded-up "two half waves in phase" aerial, giving a polar diagram somewhat sharper than a conventional 1/2λ dipole and low angle vertical plane radiation. Again, the matching at the base of the stub is degraded somewhat by the unwanted reactance of the stub, but despite this the system loads well. See Fig. 4.

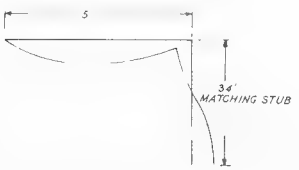


FIG. 4: Current distribution at 7 MHz. The aerial now functions as two half-waves in phase (partially folded at centre). Some reactive mismatch still occurs at the base of the stub, but operation is very effective.

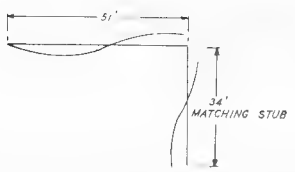


FIG. 5: Current distribution at 14 MHz. In this case, the aerial functions as a 3/2 wavelength long wire. A centre impedance of about 90 ohms is transferred to the base of the matching stub (this acts as a 1:1 impedance transformer) and results in a good match to either 75 ohm co-ax. or 75 ohm twin feeder.

21 MHz—Here the aerial works as a five half-wave long-wire giving a very effective polar diagram and good low-angle radiation. Although a bad mismatch occurs at the base of the stub, the aerial loads well and performs very satisfactorily. See Fig. 6.

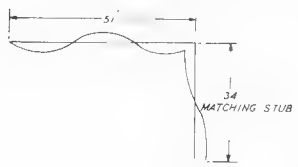


FIG. 6: Current distribution at 21 MHz. The aerial functions as a 5/2 wavelength long wire. Mismatch at the base of the stub when coupled to 75 ohm co-ax. or 75 ohm twin feeder results in a high VSWR, but operation remains effective.

28 MHz—On this band the aerial functions as two 3/2λ long wires fed in phase. The polar diagram is similar to that of a typical 3/2λ long-wire with slightly sharpened lobes and the radiation is at a low angle, good for DX working. Again, the mismatch at the base of the stub is considerable but, in practice, the aerial loads well and works very effectively. See Fig. 7.

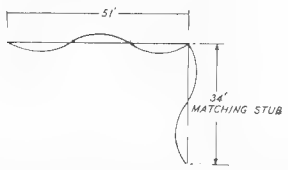


FIG. 7: Current distribution at 28 MHz. The aerial is effectively two 3/2 wavelength long wires fed in phase. Mismatch to 75 ohm co-ax. or 75 ohm twin feeder at the base of the stub causes a high VSWR, but operation is effective especially if an ATU is used.

TABLE 1

Band (MHz)	Turns	Turn Spacing (in.)	SWG	Coil I.D. (in).	Fixed Link Coil* (turns)
3.5	17 + 17	close wound	14	2.5 (former)	4 or 5
7	9 + 9	close wound	14	2.5 (former)	3
14	5 + 5	1/10	10	2.25 (self support)	2
21, 28	4 + 4	1/2	10	1.75 (self support)	1

* Alternatively, a common three-turn swinging link coil 1⅞ inch i.d., 14 SWG close wound; centre portion of coil formers cut away suitably to permit entry of swinging link coil.

THEORY OF OPERATION

The general theory of operation has been explained in the introduction. The theory of operation on each band from 3.5 to 28 MHz will now be given in turn.

3.5 MHz—On this band, each half of the flat-top plus about 16 ft. of each leg of the stub forms a fore-shortened or slightly folded-up dipole. The remainder of the stub acts as an unwanted but unavoidable reactance between the centre of the dipole and the feeder to the transmitter or ATU. The polar diagram is similar to that of a horizontal dipole. See Fig. 3.

14 MHz—At this frequency the conditions are ideal. The flat-top forms a three half-wave long-wire centre-fed aerial having six lobes of radiation, four major and two minor. As the centre impedance of a wire of this length at about 30 to 35 ft. above ground is approximately 90 to 100 ohms and the 34 ft. stub acts as a 1 : 1 impedance transformer, the match to an 80 or even 75 ohm feeder is quite acceptable. Most of the radiation in the vertical plane is at an angle of about 14 which is very effective for DX working. See Fig. 5.

In connection with the above descriptions, reference should be made to the Amateur Radio Handbook or the ARRL or "CQ" Amateur Handbooks where the polar diagrams of typical long-wire aerials may be found.

THE HALF-SIZE VERSION

Many requests have been received for information on the half-size version of the G5RV aerial for use in very restricted spaces. It is quite possible to scale all wire length dimensions (including that of the

stub) down to exactly half-size and the resulting aerial will work from 7 to 28 MHz. Optimum performance and impedance matching will occur on 28 MHz, where the operating conditions will be as for the full size version at 14 MHz.

OTHER CONFIGURATIONS

The G5RV works excellently in the form of an "inverted V" antenna. I used one with great success for six months while in Belgium as ON8RV in 1970.

Two G5RV antennas stacked, one 24 ft. above the other, preferably with the lower one a quarter wave (17.5 ft.) above ground, with the 34 ft. matching stub TRANSPOSED and the "slack" suitably taken up by folding or suitably pulling out to one side or other of the array by means of a nylon cord, will act as a multi-band version of the "Lazy-H". This arrangement has given excellent results and has been used for many years by Pete Broome G5DQ. ■

Some Thoughts on the G5RV*

Maurie Evered VK3AVO
13 Sage Street, Oakleigh 3166
*Reprinted from AR, April 1974

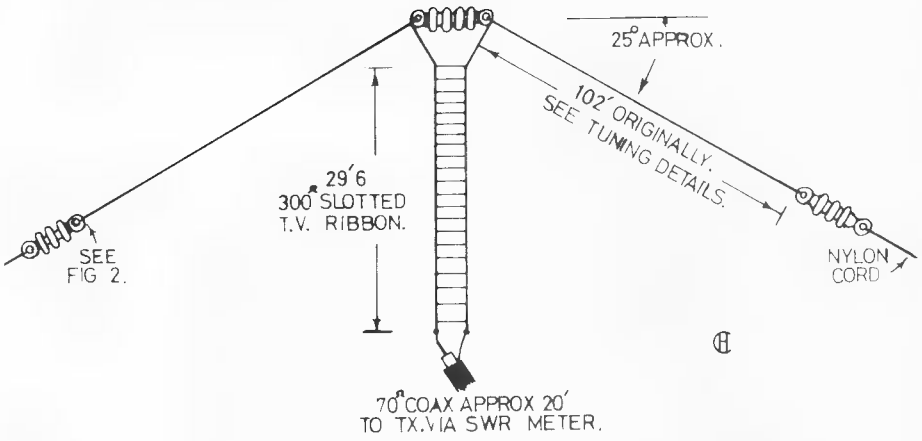
The theory of the G5RV antenna has been discussed in detail by "The Man Himself". This article, based on the author's experience, deals with some practical aspects of its use.

A G5RV has been used at this QTH for over ten years for both local and DX work on all bands from 160 metres to 2 metres. What follows is intended to help anyone who wishes to use this antenna. Much of the information given is not found in the usual texts but has been learned the hard way by many amateurs. Most of the methods used are not original but the result of helpful advice from many other VKs, particularly Vin VK3AOV who suggested I try a G5RV after a coax fed multi-dipole had proved disappointing on the higher HF bands. I will present the information under four headings.

CORRECTING THE POPULAR MISCONCEPTIONS

(a) The G5RV does not have to be used with its 102 ft. length perfectly horizontal. It can be used in a sloping configuration, as it is at this QTH (see Fig. 1) with no loss of efficiency (although some cancellation may occur if the angle of depression from the horizontal becomes too large).

(b) The length of coax cable used does seem to be important. Most operators who successfully use the G5RV have been able to confine the length of coax to less than 30 ft. Conversely, greater lengths (more than 50 ft.) may lead to poorer performance despite the fact that if good quality coax is used losses should not be severe, at least on the lower frequencies. This is an empirical finding arrived at after questioning many satisfied and dissatisfied users over a four year period.



(c) Often amateurs are heard to say that the G5RV is a compromise antenna and so must perform poorly in some respects. (No reasons are ever given, just the statement!) This is not so in practice. After all, the G5RV is no more a compromise than any other multi-band antenna (even the mighty TH6!).

TUNING

This is probably the greatest bugbear in the use of the G5RV and the reason why many operators give it away as a bad job. They are faced initially with an SWR that is considered too high or a transmitter that will not load satisfactorily, and therefore assume that the only answer is in the use of an antenna tuning unit or the use of another type of antenna. I would not recommend the use of a tuning unit or the scrapping of the G5RV in these circumstances, and suggest the method used to tune my particular antenna when it was first erected.

The antenna is tuned simply by shortening (but not by cutting) until an acceptable combination of SWR and satisfactory transmitter loading is achieved. This is done by pulling wire through each terminal insulator in turn and folding it back on the main wire (see Fig. 2).

FIG. 2: Tuning adjustment (tape securely when finalised).

Do this in steps of about six inches at a time and test after each adjustment. Concentrate first on the 20 metre band (say at 14,180-14,300 kHz) and when it is satisfactory, test on the other HF bands. These will usually be found satisfactory but some further adjustments may be necessary for the best compromise on all bands. If you have a favourite band other than 20 metres adjust for the best SWR and loading on that band.

I obtained the following results:—

BAND	SWR
80 metres	1.3
40 metres	1.6
20 metres	1.0 - 1.1
15 metres	1.6
10 metres	4.0

With this method of tuning the full original length of wire is left in case the antenna configuration is changed, or in case you change QTH. Both could require checking and probable readjustment.

USE ON 160 METRES AS A LOADED VERTICAL

I was able to load the G5RV satisfactorily on 160 metres by simply joining the two conductors of the coax feeder and then running a single wire to the pi-output of a small 10 watt AM transmitter (see Fig. 3). A buried earth wire was run to the nearest water pipe.

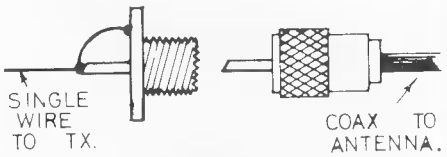


FIG. 3: Female and male coax connectors (any convenient type).

With this combination lots of local and interstate contacts were made. Strangely, in this case the addition of series inductance or capacitance had very little effect on performance. Nevertheless, some operators find it worthwhile to feed the antenna on this band via a series tuned circuit or to use a tapped inductor (see Fig. 4).

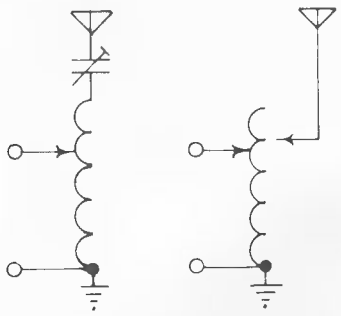


FIG. 4

Needless to say the better the earth system used the better any such vertical antenna will perform.

An elementary yet often overlooked point in resonating such an antenna was brought to my notice by Lin VK3ARL, who suggested first peaking whatever tuning arrangement is used by listening to a strong (but not overpowering) signal and

watching the receive S meter. Though the tuning position may not always coincide with that for best transmission it will be close enough to assist greatly in preliminary adjustments.

Opinions vary as to the best way of getting optimum results on transmission. Antenna current measurements are fine provided that any tuning changes do not alter the impedance at the point of meter insertion. I used a simple field strength meter but any changes are best supported by a local amateur with a reliable S meter. Don VK3ADP and Ron VK3OM obliged on many occasions.

USE AT VHF

Although it is generally not considered a VHF antenna interesting effects can be obtained because the G5RV is several wavelengths long at these frequencies (particularly at two metres) and is bi-directional

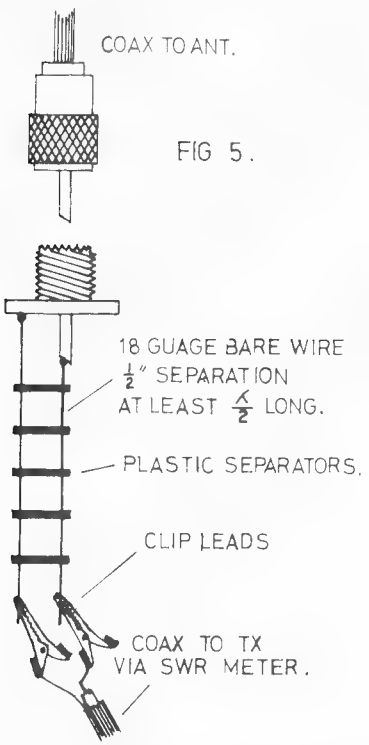


FIG 5.

FIG. 5

off its ends. The antenna was fed as in Fig. 5. Clip leads are slid up and down the parallel wires until a low impedance point is found. This gives a low SWR on the coax line to the transmitter. A tuning unit could of course be used but the method shown is very simple, very cheap, and most important, very effective.

Six metre testing was rather restricted but extensive tests were performed on two metres on channel B using an FT 2F-B. Very satisfactory results were obtained, stations being worked across the city when using the one watt output position.

Well, there it is. I would never claim that on 20, 15 or 10 metres a G5RV would equal or even approach the performance of a well adjusted quad or yagi, but I have tried quite a few wire antennas and, of these, I think the G5RV is out on its own for overall performance, size and ease of erection and adjustment. ■

Further Ideas on the Ubiquitous G5RV*

Phil Williams VK5NN
40 Hyland Terrace, Rosslyn Park, SA 5072
*Reprinted from AR, June 1974

The article by the originator of this famous antenna was extremely interesting, but there are a few further points which have resulted from re-locating my station from a quiet semi-rural QTH to an urban situation which is much more noisy. These modifications concern the low impedance feeder from the Z match to the bottom of the 300 ohm feed-line, and a method of feeding and matching the antenna as a top-loaded vertical for 160 metre operation.

The usual form of the G5RV is a 102 ft. centre-fed flat-top antenna, which works best when at least 30 ft. high. Even the G5R-inverted-V works well on a single central pole. The central feeder is usually a 20 metre half-wave resonant piece of 300 ohm or open wire line which it pays to grid-dip before erection by shorting both ends, stretching out full length and grid-dipping to, say, 14,150 kHz. From the bottom of this to the transmitter or Z match (which should always be used with a multi-band aerial) it has been usual to employ coaxial cable of 50, 70 or 100 ohms impedance.

This is fine for transmitting but the outside of the coax cable picks up more noise than I wanted to hear, and much of this is transferred capacitively to the Z match tuned circuits from the link. The 80 and 40 metre bands were worst affected in this regard.

Remedies for this were firstly to replace the coax cable with balanced feeder such as lamp flex, Telcon 72 ohm twin-lead, or a low Z balanced quad line, and secondly to earth the centre tap on the low frequency link on the Z match. A third remedy, after the implementation of the former, was the fitting of a cylindrical Faraday shield between the coils. However, this provided only marginal, though measurable, improvement.

In his original article Louis Varney mentions the use of 70 ohm twin lead or the use of 83 ft. of 300 ohm line directly to the ATU. However, I had fears about operating the former at 350 watts and high SWR, and the open wire line is sometimes unsightly in the house.

The twin lead used was twisted polythene coated copper wire from discarded multi-core telephone cable. The wire was designated 20 lbs. per mile or about 20 SWG. A balanced quad was also tried connecting diagonally opposite wires together, but little improvement was noticed. About 30 ft. of the twisted line showed no sign of distress within 350 watts PEP SSB. Black PVC tubing was pulled over the twisted pair as a weather and ultra-violet light shield where the feeder is in the open.

Noise varies with time and weather but, typically, the above measures reduced S6 or 7 levels to less than S3. The Faraday shield resulted in a further reduction of about 6 dB or 1S point, but did not make any great difference to readability of signals on 80 metres.

Fig. 1 shows the general arrangement of the G5RV and Z-match. The additional switches shown are well worthwhile. S1 enables the antenna to be switched to L2 for 10, 15 and 20 metres, or to L4 for 20, 40 and 80 metres, and saves having to jump up to unplug or operate on terminals. The other switch, S2, enables the antenna to be fed against ground for 160 metre operation. A good earthing scheme is needed, such as stakes, radials, etc., but this will not be elaborated on here.

The centre point of the link L4 is a convenient point for feeding, and both 160 metres on a receiver and another band

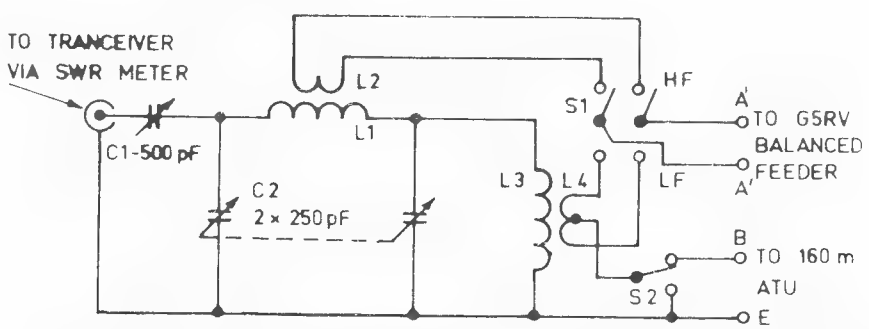


FIG. 1: Modified "Z" match — original from Radio Communication Handbook, RSGB, p.13-37, Fig. 13-60.

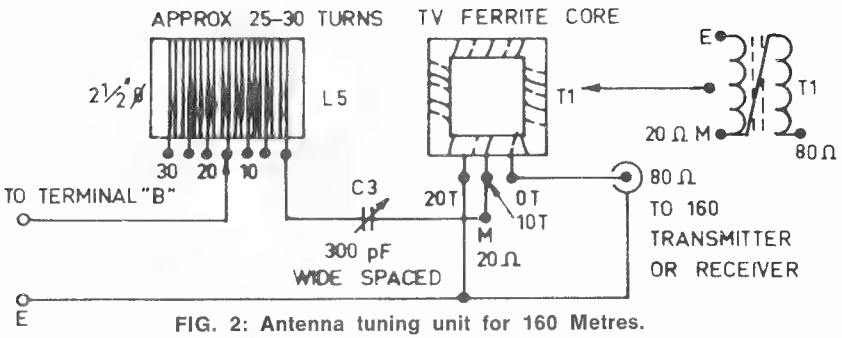


FIG. 2: Antenna tuning unit for 160 Metres.

on the transceiver may be monitored at the same time, but it is inadvisable to energise two transmitters into one aerial.

The suggested method of feeding and matching at 160 metres is shown in Fig. 2. Looking into the resonant antenna via L5 and C3 at point M with a noise bridge, for a typical G5RV at about 30 feet height, a radiation resistance of about 20 ohms is measured. The transformer T1 consists of a TV timebase ferrite core (2 sections forming a square loop) with 20 plus 10 turns (bifilar wound) to give a 4 times impedance step-up to 80 ohms, into which the transmitter pi-network loads happily.

Select a tap on L5 which permits C3 to tune 1815 kHz when near maximum capacitance. C3 may be calibrated for 1875 kHz for receiving ZL CW stations and up to 2000 kHz for other DX as required. This tuning is useful for reducing BC station overloading of the receiver front end and the resulting beats and harmonics. L5 is a coil of about 25 turns 2½ inches diameter tapped every 5 turns or so. C3 is a transmitting type capacitor of about 300 pF, with widespread plates mounted on insulators well clear of the chassis or box and with an insulated drive coupling.

I trust these notes may be of value to those 6-bands-on-one-antenna men, whose band-changing must all be done in the shack, and whose homes must not look like a Communications Unit. ■

Installing the G5RV* in only 80 feet

Louis Varney G5RV

A CONCLUDING WORD BY "THE MAN HIMSELF"

The G5RV antenna may be installed in a space of only 80 feet (24.4m) and will work very well indeed. The recommended arrangement, as shown in Fig. 1, is better than folding the ends back.

Note that many fellows have been using the wrong length for the matching stub when using ordinary 300 ohm TV line. It should be only 29 feet long. However, when using the OPEN WIRE stub (which I prefer for its lower losses, especially on 21 and 28 MHz) the correct length is 34 feet.

The most efficient arrangement is to use open wire line from the centre of the antenna right back to the ATU. If you can arrange to use a total length of 83 feet you can use a parallel-tuned ATU on all bands. It doesn't matter if the feeder has to be bent due to lack of antenna height. This is illustrated in Fig. 2.

(The length in feet can be converted to metres by multiplying by 0.3048.—Tech. Ed.) ■

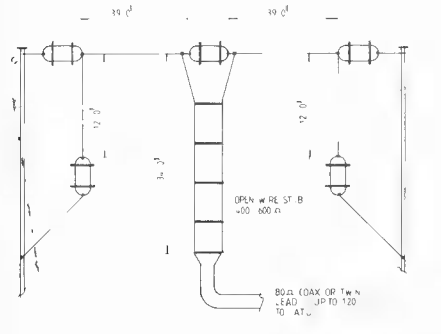


FIG. 1

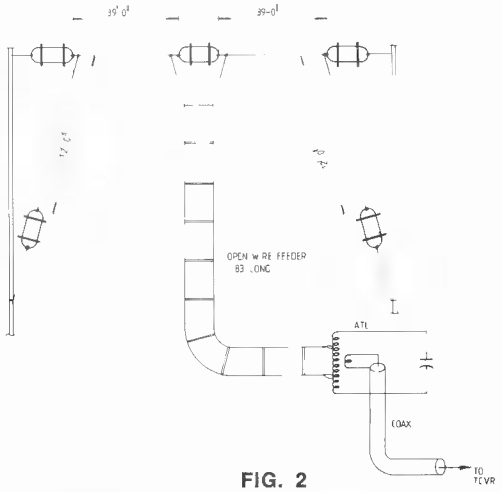


FIG. 2

Clancy of the Airwaves

From "Smoke Signals" January-February 1982

There are fools of every kind
and most of them are blind
to the folly of the game that they pursue.
And they each and all declare
that their own particular fare
is the finest in the world
"if you only knew".

The football fiend loves mud
has the fever in his blood
and the punter to the bookies gives his cash.
While the cricketer runs up and down
beneath the fiery midday sun
and the pugilists each other love to bash.

There's the chap in dancing shoes
and the musician with the blues
while the golfer hits a ball with many whams.
But the maddest of the crowd
are the ones who talk aloud
— when there's no one there — but them,
they call them 'ams!

They hover over a steel box
waffle on with VOX.
Rave about frequencies, voltages and bands
and they never go to bed
for they're funny in the head
with the knowledge this sort of thing demands.

If you ask them — which is greater
VFO or crystal oscillator
they will tell you "you're widely off the beam".
That your finals and transformer
are away to some place warmer
and DX running barefoot is just a dream.

They have wires everywhere
strung from skyhooks in the air
and their hobby is the best of all by far.
The shack is their home
as they're hardly known to roam
and their wives — unlike Clancy —
can watch the TVI and know where he are!

■

DX-ing Dolpham